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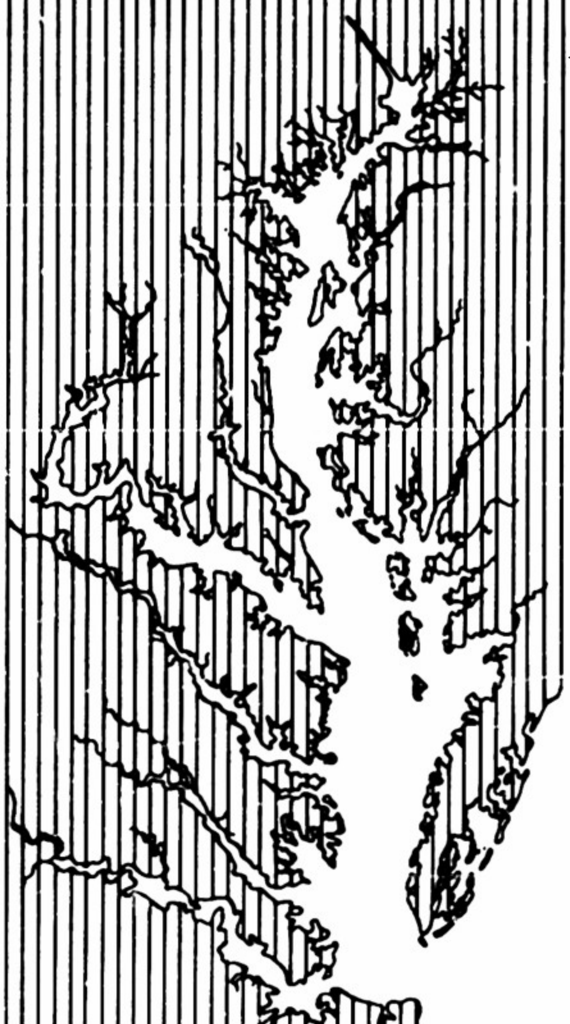

Inshore Survey Program
Interim Report XVII

FOULING ORGANISMS OF CHESAPEAKE BAY

by
J.D. Andrews
Virginia Fisheries Laboratory

Reference 53-3
March 1953

CHESAPEAKE BAY INSTITUTE
THE JOHNS HOPKINS UNIVERSITY

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Reference 53-3
March 1953

Wayne V. Burt
Project Supervisor

INTRODUCTION

The Chesapeake and Delaware Bays contain extensive areas of estuarine waters of moderate salinities. In contrast with many other estuarine areas of the world, the salinities of these waters are relatively stable. Seasonal variations occur regularly but not to the extent experienced on the Gulf Coast (Gunter 1950; Collier and Hedgpeth 1950), Carolina Sounds, South African "blind estuaries" (Day 1951), and many other coastal sounds and inlets. Many of these areas characteristically have either high salinities with a dearth of fresh-water supply, or very restricted circulations wherein either oceanic or fresh-water may predominate according to the seasonal circumstances. Other factors which may contribute to a relatively stable salinity system in Chesapeake Bay are small tidal amplitudes, considerable average depth, and moderate wave action.

The Chesapeake, with its regular supply of fresh and oceanic waters, provides a reasonably stable habitat together with an abundance of nutrients for sedentary species, of which the American oyster, _Crassostrea virginica_ Gmelin, is typical and often dominant. A great many of the fouling organisms discussed in this paper are associated with the oyster and its culture in Chesapeake Bay. The basic breeding populations of many fouling species are to be found on oyster cultch and oyster grounds.

Few papers have been published on fouling in Chesapeake Bay. Visscher (1927) examined dry-docked ships in Hampton Roads but because these ships are not clearly identified with the Chesapeake Bay in most cases, and because the data give only rough estimates of the extent of fouling, little can be deduced from this paper. Osburn (1944), in a taxonomic paper, comments on the importance of various species of Bryozoa as fouling organisms. Ferguson and Jones (1949) give a checklist

of invertebrates of the shore-line fauna of the Norfolk peninsula. This paper contains several misidentifications in the section on mollusks. Cowles (1930) gives the best general account of the distribution and occurrence of marine organisms in the Chesapeake Bay. This work is based on samples from the offshore waters of the Bay and consequently does not include many species limited to shallow waters or intertidal habitats.

Some papers on other areas are of considerable interest, in particular the studies at Beaufort, North Carolina, since many of the species studied at Beaufort occur in the Chesapeake Bay. (A checklist is available.) The most important of these papers is the one by McDougall (1943) on sessile marine invertebrates. The papers by DeLaubenfels (1947) and George and Wilson (1919) on sponges are pertinent, and to a lesser extent Fraser (1910 and 1944) on hydroids. Visscher (1927) gives an extensive bibliography on marine fouling.

The laboratories currently engaged in oyster research in the Chesapeake Bay have accumulated in their files considerable information on fouling as it relates to oyster culture. These laboratories are the Chesapeake Biological Laboratory at Solomons, Maryland, the Virginia Fisheries Laboratory at Gloucester Point, Virginia, and the Shellfish Laboratory of the U. S. Fish and Wildlife Service at Annapolis, Maryland. Much of the information in this paper is derived from the shellfish studies of these laboratories. Beaven (1947) outlined the seasonal progression of fouling on oyster shells. Truitt and Scheltema (unpublished) are currently studying shipworm activity in Chesapeake Bay.

Visscher describes the chief fouling groups on the east cost of North America, which include barnacles, mollusks, bryozoans, sponges, hydroids, tunicates, and

tube-building worms. In this report, no attempt will be made to discuss the microscopic species since little information is available. Each group will be discussed by species giving data on distribution, habitat, setting characteristics, growth, and age at maturity when known. Where exact data are not available, evaluations based on papers from other areas will be offered with reservations. Quantitative data in terms of weights per unit area are not available for any species in the Chesapeake Bay. The chief fouling species are fairly well known and considerable information on their rates and periods of setting has been accumulated.

The author made some notes on the distribution and abundance of sedentary species on the caissons used in constructing the George P. Coleman Memorial Bridge at Yorktown. Some of the structures reached a depth of about sixty feet and the approximate time of their exposure is known. These notes are given in the Appendix to this report.

DESCRIPTION OF ORGANISMS

A. Species of Mollusks which Foul or Destroy Substrata in the Chesapeake Bay

Fifteen species of mollusks contribute to fouling in the Chesapeake Bay. In Table I, the species are listed in the approximate order of importance together with the most salient characteristics of each.

TABLE I

ANNOTATED LIST OF MOLLUSCAN FOULING ORGANISMS OF CHESAPEAKE BAY

1. Brachidontes recurvus - Hooked Mussel - mostly subtidal in salinities exceeding 8-10 parts per thousand (‰); often "wraps up" oysters in low salinities; age at maturity 1-2 years (?).

TABLE I
(Cont'd.)

2. Crassostrea virginica - Oyster - all salinities above 6-10 ‰; reaches size of 4 or 5 inches in equal number of years.

3. Anomia simplex - Jingle - Salinities above 15 ‰; reaches maximum size in 2-4 months.

4. Volsella demissus - Ribbed Mussel - all salinities above 8-10 ‰; primarily intertidal on muddy shores and crevices. Maximum size attained in 2-3 years (?).

5. Mytilopsis leucophaeta - Restricted to salinities under 10-12 ‰; reaches size of 20 mm in 1 year (?).

6. Crepidula fornicata - Boat Shell, Slipper Shell; ~~salinities above~~ 15 ‰.

7. Crepidula ~~glauca~~ convexa - Convex Slipper Shell; salinities above 15 ‰.

8. Crepidula plana - Flat Boat Shell; salinities above 15 ‰.

9. Mytilus edulis - Edible Blue Mussel; salinities above 15-18 ‰.

10. Petricola pholadriformis - salinities above 15-18 ‰; uncommon.

11. Mya arenaria - Soft-shell Clam; all salinities above 10 ‰.

12. Anadara transversa - Transverse Ark; salinities above 15 ‰.

13. Anadara campechensis - Ark Clam; salinities above 15 ‰.

14. Bankia gouldi - Shipworm; salinities above 10 ‰; reaches adult size in 3-4 months.

15. Martesia smithii - Boring Clam; high salinities only; rare.

Salinity ranges: Eleven of the fifteen species of mollusks do not persist in salinities below approximately 15 parts per thousand. The exact salinity limits for each species are not known for the organisms are continually shifting up and down the tributaries from season to season and year to year. Extreme conditions undoubtedly control the distribution of a species along the boundaries of its range and time of exposure to these unsuitable conditions becomes important. Of the four species found in

waters below 15 parts per thousand, Mytilopsis is never found in salinities over 10-12 parts per thousand while oysters, hooked mussels, and ribbed mussels are found in brackish water throughout the bay.

Habitats: The first three species in the table are by far the most important of the mollusks attaching to oyster cultch. Of the three, only oysters and hooked mussels are found throughout the Bay. Anomia is limited to water over 15 parts per thousand. The ribbed mussel fouls pilings, especially where crevices are available. However, only the oyster and ribbed mussel extend appreciably into the intertidal zone.

Life Span: Oysters probably live longer than any of the other species. Commercial oysters are not infrequently five years old when harvested. In contrast, Anomia and Bankia reach adult size in a few months. The life span of the remaining species lies between these extremes. Probably individuals of all species breed in their second summer and Anomia and Bankia may produce two generations a year.

The edible mussel, soft-shell clam, and possibly Petricola begin spawning in spring and may spawn again in fall. All the rest are summer spawners although occasional individuals are found with spawn in mid-winter (Sullivan 1948).

Anomia has a relatively short life cycle. Setting occurs throughout the summer but most individuals reach full size by winter and die during the winter. Hinged shells are common in the beach drift throughout winter.

Volsella is primarily an inhabitant of intertidal mud bottoms and tolerates a wide range of salinities. Young individuals are found below low tide line but mature individuals rarely occur out of the intertidal zone.

In Virginia rivers, at least, the Crepidulas are of minor importance, possibly as a result of predation by oyster drills. A moderate population of boat

shells is often found in the lower Piankatank River, an area from which drills are excluded by fluctuating salinities.

As fouling organisms, the next three species, M. edulis, Petricola, and Mya, have been collected only from the intake pipes of the Virginia Fisheries Laboratory salt water system. Except for this habitat, Mytilus and Petricola have been found primarily in the deep waters of Chesapeake Bay proper. Mya is a fairly common burrowing clam intertidally and to some extent subtidally. Abundant sets of young Mya suggest that a heavy population of larvae is produced each year as potential fouling organisms in enclosed systems. The maximum size of specimens of Mytilus collected in the Chesapeake Bay is about one inch, far below the size attained in northern waters, suggesting that some combination of factors such as temperature, salinity, or light is not satisfactory.

The two blood clams are few in number partly because of drill predations. If necessary, blood clams and mussels can change their positions by detaching the byssal threads and secreting new ones at a new location.

The remaining two species are borers, Bankia in wood, and Martesia in shell or carbonates. Bankia strikes throughout the summer, grows to maturity in a few months, and destroys small unprotected submerged timbers in a year or less. Martesia is quite uncommon in most areas of the Chesapeake Bay. Its borings are more frequently encountered than the animals themselves.

B. Barnacles

Three species of barnacles occur on non-living substrata in the Chesapeake Bay, Balanus eburneus, B. improvisus, and Chthamalus fragilis. The first occurs principally in the lower intertidal zone and extends sparingly below the low tide line.

It is of very little importance as a fouling organism on oyster cultch, but is the most serious fouler of pilings in intertidal areas.

B. improvisus is limited to subtidal areas and causes nearly all the barnacle fouling of oyster cultch in the Chesapeake Bay. It is distributed throughout the Bay even up the rivers almost to fresh water. It occurs in greatest abundance in waters of salinity below approximately 15 parts per thousand where it is the chief fouling organism. In waters of higher salinity competitors and predators (oyster drills) reduce the population severely. This species may set during any month of the year although the major peaks of setting occur in May and August ~~or September~~ (cf. Beaven). Contrary to McDougall's findings, it is a spring, summer, and fall spawning species in the Chesapeake Bay. Typically very little or no setting occurs during February and March. Most setting seems to occur between temperatures of 15-25°C. B. improvisus reaches a maximum size of about 15 mm within two or three months in warm weather.

C. fragilis is a small barnacle with a membraneous base restricted to the upper two-thirds of the intertidal zone. It becomes abundant at the level where B. eburneus ceases to set. As might be expected, exposure to the sun influences the height of setting on pilings. No information is available on the setting period or distribution although Moore and Kitching (1939) and McDougall give details which suggest summer setting for this species. Maximum size is about 10 mm.

C. Tunicates

In Chesapeake Bay, only two species of tunicates have been recognized by the author. The common Mogula manhattensis is quite generally distributed in waters exceeding 12-15 parts per thousand salinity. These solitary tunicates mature

rapidly and disappear even more rapidly so that seasonal changes are conspicuous and frequent. Individuals reach adult size in one to three months in warm weather. Mogula can cover oyster cultch completely in a very short time in spring or fall. Exact data ~~on setting periods~~ are not available. Other species may be present.

The colonial species, Perophora viridis, appears in ~~late summer~~, multiplies very rapidly vegetatively, but disappears in winter. The basal strands persist on the substratum through the winter and the colony proliferates vegetatively when warm weather arrives. It has never been found in any abundance on oyster cultch but is fairly common on subtidal pilings during late summer.

McDougall gives good discussions of these two species, most parts of which seem applicable to Chesapeake Bay.

D. Sponges

Sponges are among the most important fouling organisms in the Chesapeake Bay in terms of area of substratum covered and damage caused. The boring sponges, of which Olds (1941) reports four species in the Bay, cause great damage to oyster cultch and live oysters by their excavations of shell. The encrusting sponges (four known species) cover cultch and young spat, thereby reducing the set of oysters.

Fortunately, most species of sponge are restricted to rather high salinities (about 15 parts per thousand or higher) and are believed to be highly susceptible to fresh water treatment.

1. Microciona prolifera Ellis and Solander. Red Sponge. This is an orange-red sponge which grows rather slowly but eventually forms clumps a foot across attached to shells or pilings. Sponge "spots" are common on shells during the summer, representing the settlement of new colonies.

2. Hymeniacidon heliophila Parker. Sun Sponge. This is a yellow sponge very common on shells and pilings. It grows very vigorously in late spring and early fall.

3. Lissodendoryx isodictyalis Carter. Garlic Sponge. This is a dirty-yellow sponge with a very offensive odor by which it may be recognized. However, most sponges have some odor. This sponge is very common on shells and pilings.

4. Haliclona permollis. Volcano Sponge. This violet-colored sponge seems to be less vigorous than the other yellow sponges, but it is widely distributed in water of high salinity. It is fragile and does not proliferate into large clumps as much as the other species.

5. Craniella crania Mueller. Brain Sponge. A very dense firm sponge which grows directly on the bottom to which it is attached by root-like fascicles. It is found on oyster grounds in deep waters, particularly in the Bay proper. This species is a fouling organism only in a very loose sense, since it does not attach to anything except mud or sand bottom. When dredging oysters in Hampton Roads and the lower Bay, it is a considerable nuisance.

6. Cliona celata Grant. Large-holed Boring Sponge. The boring sponges penetrate living and dead shells and may do extensive damage by weakening the shells and forcing the mollusks to produce new shell. They are important agents in the destruction of calcareous substrata.

7. Cliona truitti Olds; C. lobata Hancock; C. vastifica Hancock. Small-holed Boring Sponges. Olds lists three additional species of boring sponges in Chesapeake Bay, all of which produce smaller holes in the substratum than C. celata. Field identification of these sponges is almost impossible, hence the distribution and

importance of the various species are not known. Some of these sponges have greater tolerance for low salinities than C. celta. They are probably of greater importance in oyster culture than the large-holed species.

Evidently boring sponges are distributed to a large extent by asexual spores or gemmules. These resting stages apparently persist in the cavities of the sponge borings even when the shell is left to dry on land for a considerable time. When the shell is replaced in the water, the sponge gradually spreads into the shells of any oysters which set upon it.

E. Sea Anemones

At least two species of small anthozoans [probably Diadumene luciae (Verrill) Stephenson, and Cylista leucolena (Agassiz?) (Andres)] are common throughout the salinity range of the Chesapeake Bay. These sea anemones are common on submerged shell and intertidal pilings but the species are not known well enough to make further comments.

F. Bryozoans

The importance of various species of bryozoans is discussed by Osburn. Two encrusting species, Acanthodesia tenuis (Desor) and Membranipora crustulenta (Pallas), are serious fouling organisms on oyster cultch. Acanthodesia may cover fresh cultch in 30 to 60 days in some areas. Membranipora is more serious in low salinity waters, while Acanthodesia prefers salinities of approximately 15-20 parts per thousand. Only occasionally do these organisms build more than a single thin layer over the substratum, although Acanthodesia may proliferate and grow over large protrusions.

A fleshy bryozoan, Alcyonidium verrilli Osburn, is common in the lower Bay on old established pilings and unworked oyster grounds. It produces large

irregular masses under favorable conditions but is limited to subtidal areas. Victorella pavida sometimes forms velvety patches on boat bottoms and pilings in late summer and fall. It apparently is spasmodically abundant and may be scarcely noticeable during some seasons. Other species are important in fouling pilings and boats at times (see Osburn).

The filamentous bryozoans are discussed by Osburn.

G. Hydroids

Very little work has been done on hydroids in Chesapeake Bay (see Fraser). During late fall and winter a dense woolly growth of hydroids may be found on pilings and other exposed structures. They usually disappear during the spring and are most abundant from the low water mark to a few feet below the low water mark.

H. Annelids

This group of animals is probably the least known of the major invertebrate classes in the Chesapeake Bay. A great many species are free living and are found on hard substrata only when a suitable habitat is created by fouling species. The most abundant worm in the Bay is probably Neanthes succinea (Frey and Leuckart) which is found almost anywhere a bit of mud or debris is collected. This species exhibits mass spawning activities in spring, at which time the surface swarms are so thick that buckets full of worms may be collected in a short time. These worms gather under lights when swarming and conceivably could stop up intake pipes in salt water systems.

The tube building worms include a few species which build cases on hard substrata. The two species most common on oyster shells are Hydroides hexagonus and Sabellaria vulgaris Verrill. The identification of these is not certain. Both are

found only in water of fairly high salinity. Hydroides forms a calcareous shell of irregular shape and masses of these having considerable thickness are not uncommon. The tube of Sabellaria is chitoneous and flexible but helps bind dirt and debris into a tight crust. Species of Polydora are shell boring polychaete worms of considerable importance to the oyster industry. These worms have a wide distribution extending into low salinity waters.

I. Diatoms

A filamentous diatom, Melosira, forms large woolly masses on grass in shallow water during the latter part of the summer. In some seasons it may almost completely cover grass in shallow inshore areas. Other filamentous species may form a felt like layer covering shells and other submerged objects during certain seasons.

Of the larger algae, Enteromorpha and Ulva at times are a problem on oyster shells. When loose and drifting, Ulva forms windrows and is capable of clogging up salt water inlet pipes. This is also true at times of some of the red algae.

DISCUSSION

Regardless of the real factors regulating the distribution of fouling organisms in Chesapeake Bay, a simple division into high and low salinity areas serves as a useful practical guide to estimation of probable fouling. While no exact division can be made because of shifting salinities, the effects of temperature, and other factors, the lower salinity limit for many organisms is about 12-15 parts per thousand. In salinities below this range fouling is intense but limited to a very few species, particularly Balanus improvisus, Brachidontes recurvus and Membranipora crustulenta.

In salinities higher than this range practically all the species listed in this paper compete for space but few gain much dominance.

In general, the deterioration of pilings and cultch will follow this simple division too, for the wood boring and shell boring species are limited to waters of higher salinity.

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APPENDIX

Notes on Yorktown Bridge Pilings

During September 1951, the Massman Construction Company removed the framework which held the bridge caissons in position and deposited it bodily on the beach by means of a derrick boat. It consists of four vertical steel tubes (10-12 inches in diameter) with horizontal and 45° angle braces made up in 5 twenty-foot sections with 10 foot "legs" on the bottom. The framework was one of the channel structures, probably set in position in May 1950, and was buried in the mud to about the depth of the "legs." The low tide line was almost exactly at the 80 foot level where a horizontal crossbar provided extra surface for study. Whether the pipe had been painted or cresoted does not now appear since it is a rusty brown where-ever visible. The total period of exposure in the water was probably 15 or 16 months and quite obviously this piling had not been moved or disturbed in its position during this time. The oysters and other fouling organisms are of a size that indicates that the major set occurred in the summer of 1950.

The author was able to examine the whole length of the frame minutely before the organisms had died. The pilings were nearly 100 per cent covered by fouling organisms. Perhaps 90 per cent of the fouling was caused by the organisms which are given in the following list in the approximate order of importance, that is, according to the amount of surface covered.

1. Hymeniacidon heliophila and Lissodendoryx isodictyalis. These two sponges were not distinguished by the author in September 1951, but it is now recognized that both are very common at Gloucester Point.

The yellow sponges were abundant at all levels below the low tide mark but perhaps a little thicker near the surface than near the bottom.

2. *Hydroides hexagonus*. Equally abundant at all depths.

3. *Balanus improvisus*. Common at all submerged depths.

4. *Moigula manhattensis*. Present at all depths, but most abundant in upper 20 feet.

5. *Cylista leucolena* and *Diadumene luciae*. Very abundant at all depths.

6. *Anomia simplex*. Many small specimens of the 1951 set. This was the most abundant mollusk from top to bottom.

7. *Acanthodesia tenuis*. This bryozoan was present at all depths, but proliferating most in the upper two feet--sometimes popping up into bubbles over sea squirts or yellow sponge, especially in the upper foot.

8. *Alcyonidium verrilli*. Colonies 4-6 inches long usually mixed with coelenterates.

9. *Sabellaria vulgaris*. Moderately abundant at all depths.

10. *Crassostrea virginica*. Few in number but fairly large. Present from top to bottom.

It will be noted that these ten common fouling species were found at all depths although some were most abundant at particular levels.

The appearance of the intertidal zone and the first few feet below the low tide line differed considerably from the rest of the submerged surfaces. In addition to the species already listed, this subtidal zone was characterized particularly by three additional species:

11. A filamentous hydroid with 4-5 inch strands-- very dense in a two

or three foot band below low tide line.

12. *Caprella acutifrons*. Millions of these small predatory amphipods were clinging to the filamentous hydroid.

13. *Balanus eburneous*. A few at all depths but by far the greatest concentration in a 10-12 inch band at the low tide line. This species was especially abundant on the shady side and extended higher on the frames on the shady sides.

The remaining species found on the pilings were either small, migratory, or not abundant. They include the sedentary mollusks (14-18) whose populations were sparse and often localized.

14. *Crepidula fornicata* and *C. plana*. Present but very scarce.

15. *Mulinia lateralis*. A large number found in one corner in the upper few feet near the low tide line but not found below that.

16. *Mytilus edulis*. Very sparse at all levels.

17. *Anadara* sp. The two species not distinguished but specimens still available. Much more abundant at the bottom especially at the 20 foot level where they were accumulated in groups, having dropped out of the hollow sections of the piles. Sventy-five specimens were collected at one joint.

18. *Laevicardium mortoni*. One specimen found with the Mulinias.

Miscellaneous species:

19. *Anachis avara*. A colony of these snails was found in the lower two or three feet just above the bottom--all 15 specimens were within 24 inches of each other.

20. *Urosalpinx cinereus*. These drills found only in the lower 20 feet.

21. Mud crabs. Several species appeared to be abundant at all depths. This distribution is amazing when it is realized that mud crabs cannot swim and must have crawled up the pilings or have been hatched there.

22. Unidentified annelid. Large (3-5 mm diameter) mud tubes six to eight inches long laid casually over the substrate. Tube fragile, appears to be pure mud without matrix. Highest specimen at six foot level, otherwise sparse and uniformly distributed.

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1	Commanding Officer Mine Warfare School Yorktown, Virginia
10	Hydrographic Office U. S. Navy Department Washington 25, D. C.